SPECIFICATIONS FOR INDUCTIVELY COUPLED PLASMA (ICP) ETCH SYSTEM

The Naval Research Laboratory (NRL) has a requirement for an Inductively Coupled Plasma (ICP) etch system. This system will be used to do anisotropic etching requiring very low surface damage to the material or deep etching (> 5 micron). Materials to be etched include GaN, and Si with the possibility of Aluminum and III/V materials, e.g., GaAs. It shall be designed with the proper protections (high vacuum, load lock, chemical mechanical backing pump, the proper chamber and vacuum pipes and connector materials, etc.) to withstand etching with chlorine gases as well as fluorine. The chlorine gases should cause neither corrosion within the system nor a safety hazard. The chamber shall be capable of handling wafers up to 4" with <5% variation in the etch rate across the sample. Sample size shall not be standardized. There should be no RF radiation outside the network itself. The system shall meet all the government and industry safety standards and meet or exceed the following specifications:

1. A Reactive Ion Etching (RIE) reaction chamber shall include:
   - •etching chamber and chuck, to be made from anodized Aluminum
   - •chilled chuck capable of handling wafers up to 4" (100mm) as well as smaller samples

2. Inductively Coupled Plasma (ICP) source shall be able to generate a high-density plasma for remote delivery of activated gas species into the etching chamber. This shall include:
   - •3000 Watt, 13.5 MHz RF Generator for extraction bias for the ICP source
   - •600 Watt biasing on the chilled chuck (lower electrode), independent from the ICP source
   - •Internal fixed matching network for the biased chuck

3. An independently pumped vacuum loadlock, chamber on the system shall be able to keep the etching chamber isolated from air and under vacuum so that chlorine etch chemistries can be safely used and to enhance reproducibility. The loadlock system shall include:
   - •mechanical roughing pump for evacuation,
   - •gate valve between the two chambers for isolating the loadlock chamber from the etching chamber
   - •mechanism for transferring the sample from the loadlock chamber onto the chuck in the etching chamber.

4. Automatic Control system (with manual override):
   - •shall be PC controlled, Windows user interface
   - •shall be Fully interlocked
   - •shall have Controllable parameters: process gas line and flow rate, RF power (with network matching), DC bias voltage to chuck, chamber pressure and N_2 purge

•shall display and record operating parameters: process gas flow, chamber pressure, RF power (input & reflected), dc bias voltage on chuck
•shall display status (on/off): vacuum valves, chilling water flow
•shall have emergency Off button

5. ICP vacuum system shall include:
   •all pipework needed for the source and chamber
   •all tubing and gate valves for the vacuum system
   •base pressure of system in low 10^{-7} torr range
   •pressure gauges
   •automatic pressure regulation system with throttle (butterfly) valve to etching chamber

6. Gas Delivery system to the etching chamber shall include:
   •8 gaslines to the system
   •isolation valves
   •at least 4 mass flow controllers in the ranges: 0-20, 0-50, 0-100, 0-200 sccm
   •capacity for a total of 8 mass flow controllers to system

7. Installation at this facility and training for at least one operator shall be included.

8. Set of manuals (operation, maintenance and schematic drawings) shall be included.

Optional Items:

The ICP etching system that is being purchased for use in the NPF shall meet the specific needs of existing customers and also satisfy future needs. There is an expanding customer base interested in etching Si_3N_4 and other customers interested in deep Si etching, both requiring chlorine chemistry as well as the special properties of the ICP etcher (low surface damage, high etch rate, anisotropic etching). Because of the toxic and corrosive properties of the chlorine chemistries to be used, this ICP etcher must be configured with certain components.

1. Osaka 440 Helical Groove Pump
   (alternately - a high pumping capacity (e.g., 1600 l/s magnetically levitated) turbo-molecular pump)

2. Roughing Pump - 60 cfm corrosive series dry pump
   Because this etcher runs under high vacuum, it requires a pump with high pumping capacity able to reach high vacuum, as well as a mechanical pump for roughing. The mechanical pump shall be a chemical corrosive pump to withstand the corrosive properties of the chlorine gas and its byproducts.

3. Corrosive Gas Module including 12 gauge gas enclosure with self closing doors, all welded VCR plumbing, 2 mass flow controllers and automatic purge system
   A corrosive gas module is a requirement for this system when chlorine is to be used.

4. Recirculating Cooling System (capable of handling ICP heat load)
   The high power ICP etching system puts out (3000W) and requires that the temperature be regulated during the etching process using a recirculating temperature controller. This enhances process reproducibility and makes the etch byproducts more readily volatilized.